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Using Synthetically Modified Proteins to Build Integrated Photocatalytic Systems

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The protein capsids of viruses provide a convenient source of rigid, nanoscale scaffolds for the construction of complex multifunctional materials. These proteins can be produced in large quantities through expression in *E. coli* and can be genetically tailored to possess reactive groups for the positioning of synthetic molecules on their surfaces. Through this program, we have explored the use of two capsid-forming proteins to build light-harvesting systems and connect them to photocatalytic groups. In one example, we have developed chemical strategies to attach the rod-like protein shell of the tobacco mosaic virus to polymers, carbon nanotubes, light-harvesting chromophores, and porphyrins. As a second target, methods have been developed to append new functionality to both the external and internal surfaces of MS2 viral capsids. These spherical assemblies have been used to house chromophores that collect light and transfer the energy to catalysts located on the exterior surface. Taken together, these new scaffolds provide many new avenues for the integration of multiple functional components with defined spatial relationships. Equally important for these studies is the set of chemical strategies that has been developed to modify biomolecules with high site selectivity and yield.